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GEOLOGY AND PALEONTOLOGY.

Phylogeny of the Dipnoi.—In a memoir recently published, M. Dollo adduces fresh evidence for the theory recently advanced by various English scientists that the diphycercy among the Dipnoi is in reality a secondary diphycercy or gephyrocercy. The author regards this as an important fact, and uses it as a basis in developing his theory of the origin and evolution of the order. The results of his researches are as follows:

I. *Dipterus valenciennesii* is the most primitive of the Dipnoi known.

II. In a general way, the evolution of Dipnoi, since the lower Devonian, is represented in the following series in the order of the enumeration of its terms.

Dipterus valenciennesii—Dipterus macropterus—Scaumenacia—Phaneropleuron—Uronemus—Ctenodus—Ceratodus—Protopterus—Lepidosiren.

III. The origin of the Dipnoi must be looked for among the Crossopterygia.

IV. The Batrachians are not in the line of the Dipnoi.

V. The specialization of the Dipnoi has been from a pisciform type toward an anguilliform type.

This order is a terminal group, derived from the stem that gave origin to the Batrachians.

In conclusion the author gives the phylogeny of the gnathostome vertebrates in a tabulated form. (Bull. Soc. Belge de Geol. T. ix, Fasc. 1, 1895, Bruxelles, 1896).

Fauna of the Knoxville Beds.[1]—The Knoxville beds are a Cretaceous series confined to the coast ranges of California, Oregon and Washington. They are characterized by the great abundance of Aucella, usually without associates, but, through the explorations of Mr. Diller and other geologists, a rich and varied invertebrate fauna has been discovered in the Aucella-bearing series of the Pacific States.

The description of this fauna was assigned to T. W. Stanton, and is now published as Bulletin No. 133 of the U. S. Geological Survey. The author recognizes 77 distinct species and varieties, of which 50 are new. All but 7 of the species are Mollusca, including 33 species of

[1] Bulletin United States Geological Survey, No. 113. Contributions to the Cretaceous Paleontology of the Pacific Coast; The Fauna of the Knoxville Beds. By T. W. Stanton. Washington, 1895, [issued Feb. 3, 1896].

Pelecypoda, 1 of Scaphopoda, 18 of Gastropoda, 18 of Cephalopoda (15 Ammonoids, 3 Belemnites). The other 7 species include 5 Brachiopoda and 2 Echinodermata.

The brief introduction comprises a geological description of the beds, with a discussion of their age, and of their relations to various other formations characterized by a similar fauna.

The new species are figured on twenty page plates.

Notes on the Fossil Mammalia of Europe, IV.—ON THE PSEUDOEQUINES OF THE UPPER EOCENE OF FRANCE.—Under the term Pseudoequines may be included the various species of the genus *Paloplotherium*, which occur in the Upper Eocene and Oligocene of Europe. This phylum parallels in a remarkable manner many of the characters which are typical of the true horses, but these characters, strange to say, are much earlier differentiated than in the real equine phylum.

Kowalevsky[2] in his great work on "*Anthracotherium*" clearly recognizes in his phylogenetic table of the Ungulates, that *Paloplotherium* is not in the direct line of the horses. Schlosser is also of the same opinion as Kowalevsky in regard to the relations of *Paloplotherium* to the horses. Professor Gaudry[3] as late as 1888 placed all the species of *Paloplotherium* in the direct line leading to *Equus*.

The earliest known species referred to *Paloplotherium* is the *P. codiciense* Gaudry; this form is from the Calcaire Grossier or Middle Eocene. In *P. codiciense* there are four upper and lower premolars, whereas in the more typical species of *Paloplotherium* from later deposits there are only three premolars. Moreover, in the *P. codiciense* all the upper premolars are simpler in structure than the true molars. The last upper premolar in this species is tritubucular in structure, and there are two well defined crests running outwards from the deutero-cone, in other words this tooth is well adapted for further evolution into the molariform last premolar of the typical Paloplotheroids. In the true molars of *P. codiciense* the ectoloph has nearly the same form as that of the Palaeotheridæ in general, the metaloph or posterior crest, however, is less oblique in position than in the later species of *Paloplotherium* and *Palœotherium*. The type specimen of *Paloplotherium codiciense* consists of a facial portion of a skull with the teeth well preserved. This species is much larger than *P. minus* and corresponds more nearly in size with *P. annectens*.

[2] Monographie der Gattung Anthracotherium, p. 152.

[3] Les Ancêstres de nos Animaux, Paris, 1888.

In "La Petite Galerie" of Paleontology at the Jardin des Plantes, Paris, there is a well preserved skeleton of *Paloplotherium* which is labelled *Paloplotherium minus*. This specimen is of some importance, as we have here a case where the skeletal parts and teeth are associated and from the same individual. This skeleton was found in the Calcaire Grossier de Dampleix, Department of Aisne,[4] and it is important to add that Professor Gaudry's type of *P. codiciense* is from the same horizon of this Department, but from another locality.

Although this skeleton has been determined as *P. minus* it differs widely from this species, and also in fact from *P. codiciense*. In the upper and lower jaw there are four premolars as in *P. codiciense*, but these teeth are much more complicated than in that species and are exactly transitional in structure between *P. codiciense* and the typical species of *Palæotherium*. The premolars in this type are badly worn, but I can distinctly trace on one side that the internal cones are nearly double, but not distinctly separated as in *Palæotherium;* the structure the true molars is like that of *P. codiciense*. As will be seen the dentition of the skeleton above referred to differs from *Paloplotherium minus* in having four premolars, also the second upper tooth of this series is more complex than in the latter.

The parts of the skeleton associated with the teeth and skull consist of a scapula, radius and ulna, and also some metapodials. Among the latter there is a Mc. III and also another metacarpal, which I think may be Mc. V. If this determination be correct, we have here a Palæotheroid with four digits to the mamus. In the species of *Palæorium* from the Upper Eocene, Mc. V is represented only by a rudiment. I would like to add that the metapodial in this skeleton which I have determined as Mc. III is flatter and less triangular in section than in the typical *Paloplotherium minus;* this goes to show that the lateral toes were larger, and supports my view as to the presence of four anterior digits in this as yet undescribed species.

From the characters above adduced I conclude that this new species of Palæotheroid is more closely related to the true *Palæotherium* than to *Paloplotherium*, and moreover it is the most primitive form of *Palæotherium* yet discovered.

I am not able to learn that the beds in which this skeleton was discovered are any later than those in which the *P. codiciense* was found. However, from the structure of the premolars in the two species, I would conclude that *P. codiciense* came from an earlier subdivision of

[4] I am much indebted to my friend M. Marcellin Boule of the Jardin des Plantes for having given me information in relation to this specimen.

the Calcaire Grossier of Aisne than that in which this skeleton was found.

The most abundant species of *Paloplotherium* found in France is the *P. minus.* This species was described by Cuvier and referred to the genus *Palæotherium,* but it was later raised to a generic rank by Owen, and also by Pomel. In regard to *Paloplotherium minus* it is of importance to attempt to show that the teeth and feet of this species are properly associated. Osborn and Wortman[5] have lately questioned the correctness of this association, and furthermore these authors think it probable that the feet referred to *P. minus* by the French Paleontologists really belong to a small species of Lophiodont-like animal, closely related to the American genus *Colodon.* I cannot agree at all with these authors in this supposition, as I believe that the feet tending to monodactylism found in the Upper Eocene of France, which are referred by the French Paleontologist to *Paloplotherium,* are correctly identified.

Among the large collection of fossils in the Jardin des Plantes, many of which formed the types of Cuvier, and which were described by him in his "Ossemenes Fossiles," there is a nearly complete skeleton referred by Cuvier to *Paloplotherium minus;* this is figured by Cuvier[6] and also by Blainville.[7] In this specimen the feet are absent, but there are a few teeth embedded in the skeleton which have the same structure and size as those referred to *P. minus.* Again, Blainville figures an anterior extremity of a small Perissodactyles which he refers to *Paloplotherium minus,* and this specimen is of the same size as the fore limb of the nearly complete skeleton of *P. minus* described by Cuvier. Both these specimens are from the Gypse de Paris. However, since the time of Cuvier, *Paloplotherium minus* has been found in great abundance in the Upper Eocene of Débruge. The collection in the Jardin des Plantes from Débruge contains a large number of jaws and teeth, and portions of limbs containing numerous metapodials. These bones correspond exactly in size with those of the original skeleton described by Cuvier, and I am of the opinion that this is pretty conclusive evidence that the skeletal parts of *Paloplotherium minus* and the teeth are correctly associated. Moreover, I am not aware that any small Lophiodont Perissodactyle occurs in the Débruge Eocene. I use the term "Lophiodont" strictly in the sense as applied by Osborn and Wortman.

[5] Bulletin American Museum Natural History, 1895, p. 361.

[6] Ossemenes Fossiles, plate 115.

[7] Osteographie, Blainville, Palæotherium, plate VI.

Having now attempted to show that the monodactyle type of foot found in the Upper Eocene of France is in all probability correctly associated with the teeth of *Paloplotherium*, I shall review the characters of this phylum and indicate those points which parallel the true horses, and also point out those aberrant structures of the teeth which exclude the possibility of placing this series in the direct line leading to *Equus*.

Through the kindness of Professor Albert Gaudry, I have been enabled to study a beautifully preserved skull of *Paloplotherium javvalii* from the Phosphorites. This cranium is remarkably like that of the horse in many of its characters, and I think most Paleontologists would say at once that this type of horse-like skull should be associated with a foot tending to monodactylism. The position of the orbit is as in the primitive horses, its anterior termination being placed over the second true molar. The form of the facial region closely resembles that of the horse, being high and strongly compressed. The premaxillaries are elongated and slender, and slope gradually backwards as in the horse. Among the Palæotheroids, *P. crassum* has a skull resembling somewhat that of *Paloplotherium javalii*, but in the former the facial region is shorter and broader than in *P. javalii*. In the skull of *P. javalii*, there is a large flat area between the orbits, and the sagital crest is well marked. The post-orbital processes of the frontals are largely developed and extends well downwards towards the zygomatic arch. The post-tympanic and paroccipital processes are united as in *Palæotherium crassum*. The basal region of the skull in *P. javalii* is long and narrow, like that of the horse.

The structure of the skull in *Paloplotherium minus* is not known, only fragments of the occiput having been found. The teeth of *P. javalii* have been described by M. Filhol, and as is well known the crowns of the upper molars are much elongated and tending strongly to the hypsodont condition of *Equus*. Moreover, the valleys between the crests are filled with cements and the external and internal surfaces of the crown are coated with the same substance.

In *Paloplotherium* the last upper premolar is completely molariform and the posterior crest of this tooth, and that of the true molars is very oblique in position. The metaloph owing to its oblique position, only unites with the ectoloph after a long period of wear; this crest, in the true horses, moreover, is nearly at right angles to the ectoloph and unites early with the latter. In *Paloplotherium* also, the hypostyle—an element so essential in the evolution of the horse's molar, is absent. The lower true molars in the Paloplotheroids lack the reduplication of

the metaconid, which is present in the members of the true Equine phylum.

No metapodials of *P. javalii* have been found associated with the teeth; however there are in the collection of the Jardin des Plantes and also in the École des Mines, a number of enlarged third metacarpals and metatarsals from the same beds in which they find the teeth of *P. Javali*, and in all probability belong to this species. As already stated the horse-like skull and teeth of *Paloplotherium javalii* support the view that this type of cranium belong with these specialized metapodials. The third metacarpal in *P. javalii* is long and slender, and has a large facet for the unciform, the section of this bone is triangular with the lateral surfaces very oblique. This structure of the metapodial shows that the lateral digits were placed far to the inside and behind. The posterior cannon bone is more progressive in its horse-like character than the anterior, the proximal surface is much expanded transversely and the postero-lateral cavities for the metapodials are placed further behind than in the fore foot.

M. Filhol has described remains of *Paloplotherium minus* from the Oligocene of Ronzon, and in these beds they again find the enlarged third metapodials which are so abundant in the Débruge Eocene. This is another proof that the teeth and podial elements in *Paloplotherium* are properly referred.

A form closely related to the Palæotheridæ is the genus *Anchilophus*. This genus is more normal in its tooth structure in comparison with the early horses than *Paloplotherium*, and is considered by some authors[8] as in the direct line leading to *Equus*. Kowalevsky[9] however, calls *Anchilophus* a "Versuchgenus in der Pferderichtung, der Versuch war aber erfolglos, und der Anchilophus erlischt im Eocän, ohne directe Nachfolger zu hinterlassen." Kowalevsky reached this conclusion from studying the carpal bones of *Anchilophus*. I have had access only to the teeth of *Anchilophas desmarestii* and consequently must base my conclusions upon the characters of one species only of this genus. A comparison of the superior molars of *A. desmarestii* with those of *Mesohippus*, a genus which is considered by all competent authorities to be in the true Equine series, shows the following differences: The ectoloph in both genera has nearly the same form, but in *Anchilophus* the mesostyle is absent, this is well developed in *Mesohippus*. In *A. desmarestii* the hypostyle is wanting, which is so prominent in the molars of *Mesohippus*. The direction of the metaloph in *An-*

[8] Etudes sur l'Historie Palaeontologique des Ongules. Par Mme. Pavlow. Bull. Soc. Nat. de Moscou, 1888, p. 148.

chilophus is less oblique than in *Paloplotherium* and is more as in *Mesohippus*. In the lower molars of *Anchilophus* the metaconid is not reduplicated, and the crescents are in form more like *Palaeotherium*.

From the fact that Kowalevsky, in studying the podial elements of *Anchilophus*, concluded that this genus could not be in the true Equine series, adds much weight to the view of its non-persistence. Again, we have seen that the molars of *Anchilophus* are wanting in a number of important elements which are present in all later genera leading to *Equus*. The above evidence points to the fact that *Anchilophus* must be considered as another aberrant form not leading to permanent results.—CHARLES EARLE.

Reclamation of Deserts.—The shifting of the sand dunes in the Sahara desert frequently ends in destruction of fertile oases. To prevent the encroachment of the dunes upon the arable land has long been a problem with the French. Commandant Godron has inaugurated a system of tree planting in the neighborhood of Aïu-Sef-ra, Ouargla and El-Golea from which excellent results have been obtained. Following out the theory that tree plantations would prevent the dunes being at the mercy of the wind, and finally make them stationary, M. Godron planted a neighboring dune with seedlings of various species of trees and shrubs. To prevent the sand from shifting while the new plants were establishing themselves, a light covering of alfa straw was spread over the ground. This was found to effectually shield the sand from the action of the wind.

In making a plantation, Mr. Godron combines seeding, cuttings and plants already rooted. The species best adapted for growing on the dunes have proved to be the Barbary fig, peach, aspen, Italian poplar, weeping willow, *driun*, grape-vine, Spanish broom, acacia and roses.

To supply the demand for cuttings and rooted plants for this new desert industry, M. Godron has established local nurseries at Aïu-Sefra and at El-Golea. The water supply for maintaining the growth of vegetation is from artesian wells. The reclaimation of vast extents of desert land is hoped for in the future, through the adoption of the plantation methods of Commandant Godron. (Revue Scientif., Fev., 1896).

[9] Anthracotherium, p. 157.